HCal Light Collection Efficiency Correction Simulation Study

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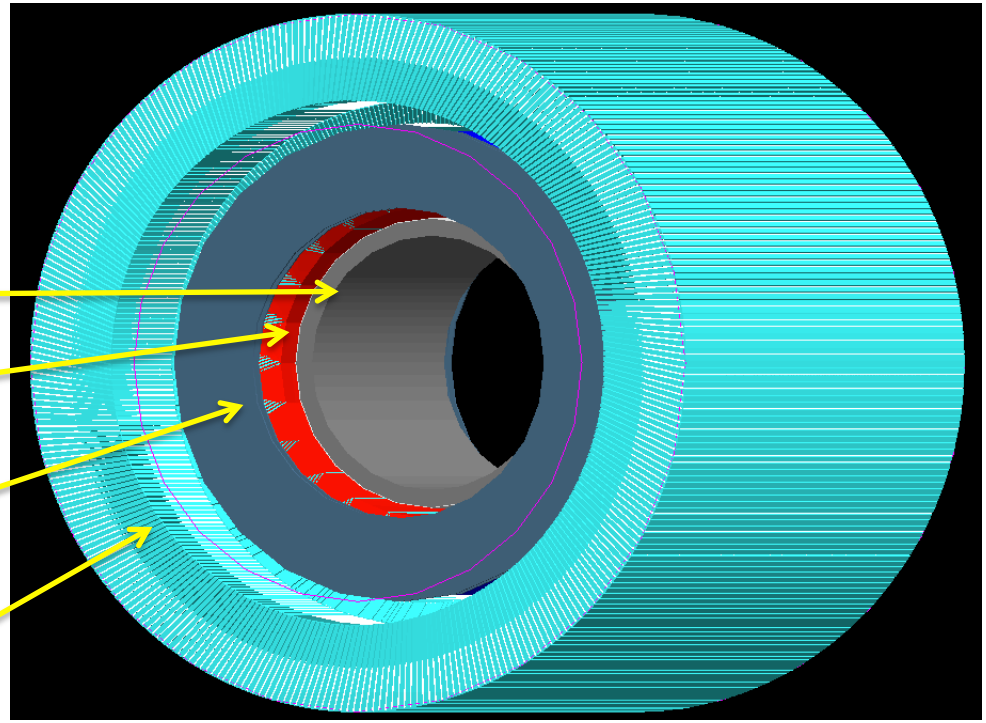
Detector Configuration

- SPACAL + Inner HCal + Magnet + Outer HCal
- Inner HCal:
  - Scint tile / Stainless steel
  - R(in)=116 cm, R(out)=135 cm
  - Scint thickness: 0.7 cm, # Scint tiles: 64x5
  - Tilted-angle: 29.4^{o}
- 1D projective SPACAL
- sPHENIX field map
- 5 k, 30 GeV charge pion

- Outer Hcal:
  - Scint tile / Fe
  - R(in)=178 cm, R(out)=260.3 cm
  - Scint thickness: 0.7 cm, # Scint tiles: 64x5



HCAL Reference Design

New sPHENIX software

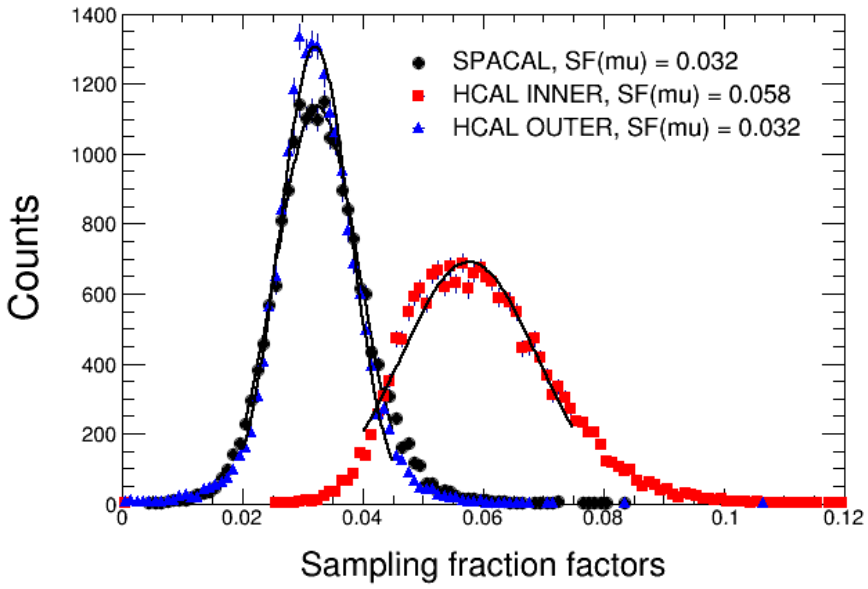
Pure G4Hit, ideal towering

/direct/phenix+sim01/phnxreco/users/lxue/G4Sim_RefDesignLightYield/spacal_hcal

Sampling Fraction Factors

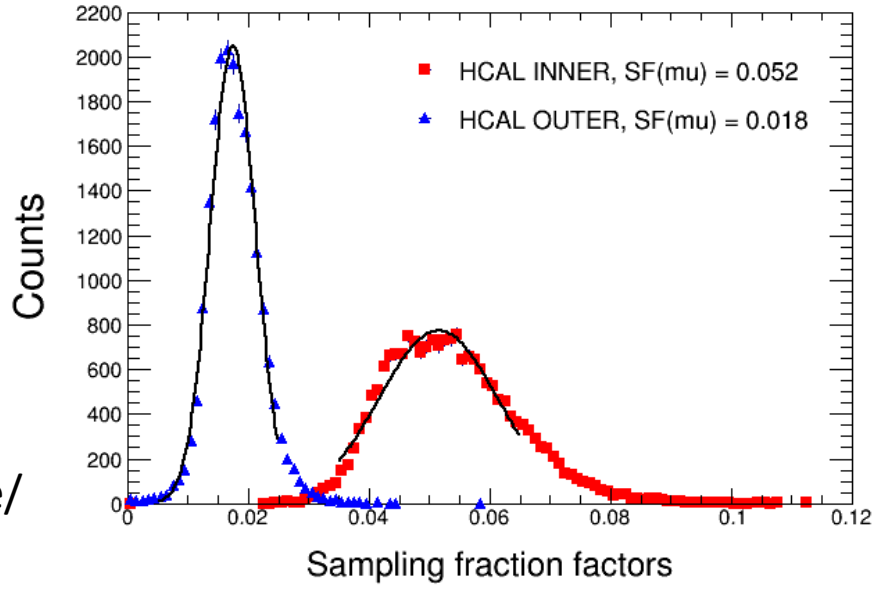
Before light correction, sampling fraction factor calculated from muons via :

$$SF(mu) = \frac{Escint(mu)}{Escint(mu) + Eabsorber(mu)}$$



After light correction, sampling fraction factor calculated from muons via :

$$SF(mu) = \frac{Escint(mu, light-corrected)}{Escint(mu) + Eabsorber(mu)}$$

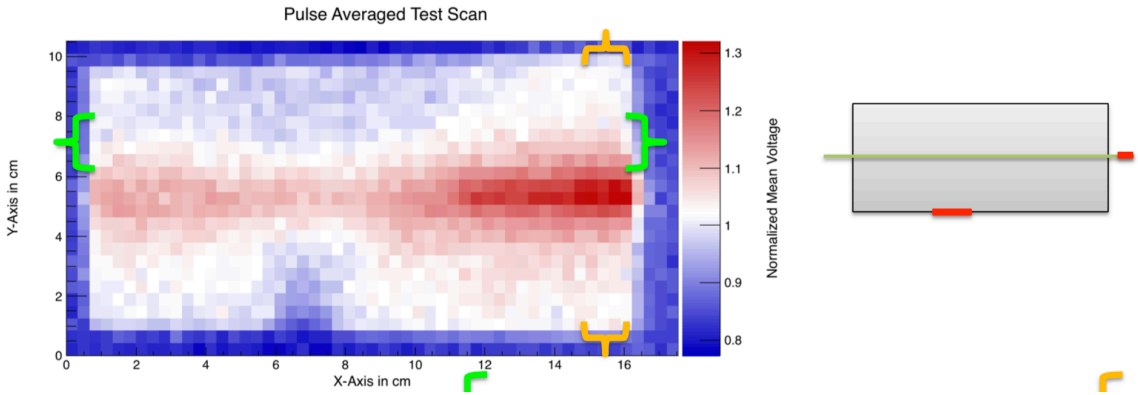


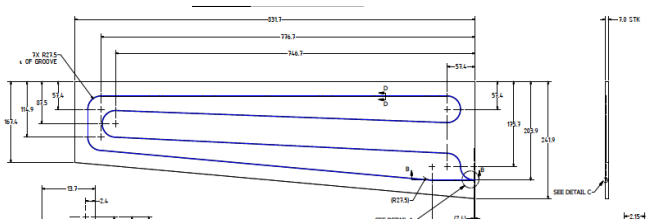
/direct/phenix+sim01/phnxreco/users/lxue/G4Sim_RefDesignLightYield/SF/mu/

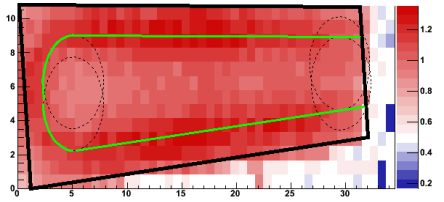
Light Collection Efficiency

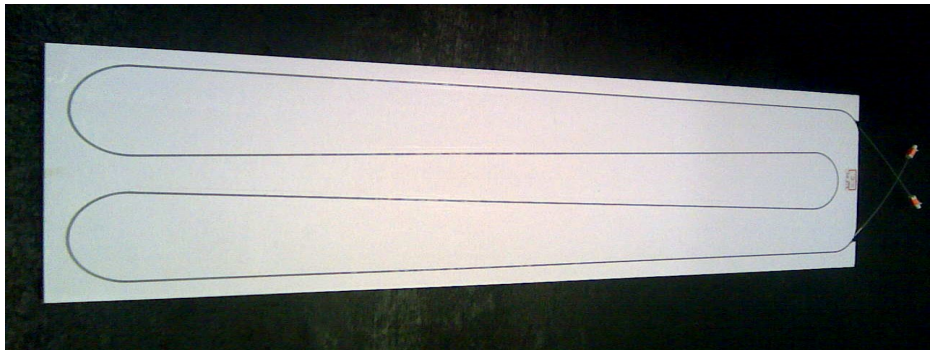
- Previous study assume a uniform light collection efficiency.
- Light collection efficiency is different for photons at different position of the scintillator tile.
- A linear light collection efficiency correction is applied by assuming:
  - HCAL INNER: Eff(R_{out})=1.0, Eff(R_{in})=0.8
  - HCAL OUTER: Eff(R_{out})=1.0, Eff(R_{in})=0.15

$$eff = \frac{1.0 - 0.15}{R_{out} - R_{in}} \times (r - R_{in}) + 0.15$$









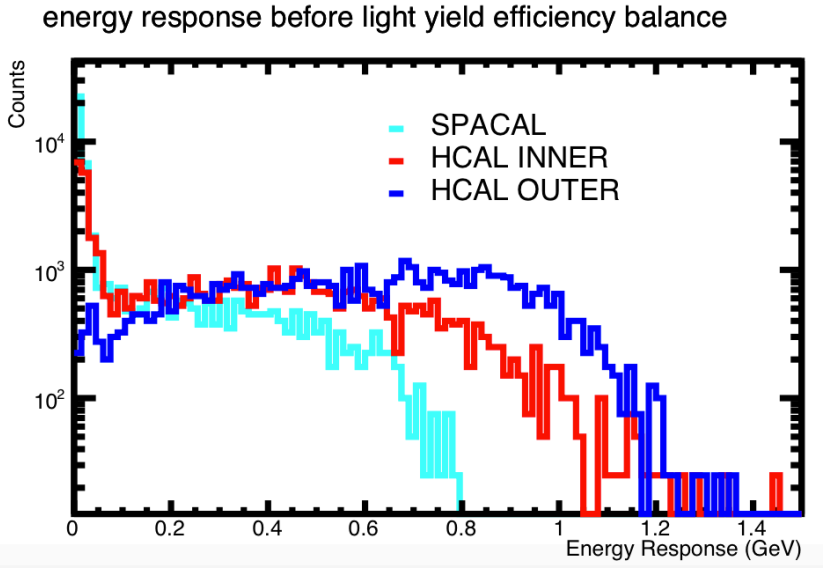
https://indico.bnl.gov/getFile.py/access?contribId=3&resId=0&materialId=slides&confId=1175

E. Kistenev

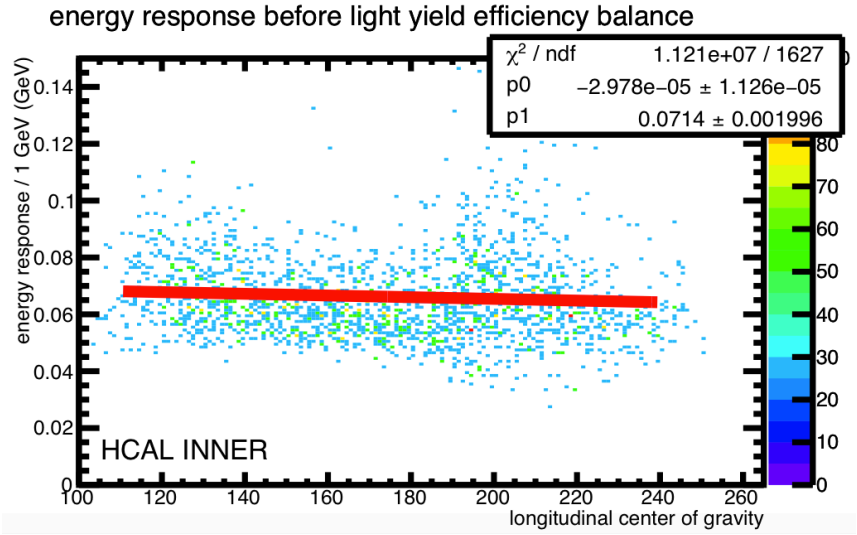
Energy response, sampling factors before light correction

- A spike (channeling / punch through) at 0 for energy response in HCAL outer.
- Slight decrease trend for SF vs. longitudinal center of gravity (LCG) for HCAL inner.
- HCAL outer SF is dependent on LCG/ radius (decrease trend) as expected.

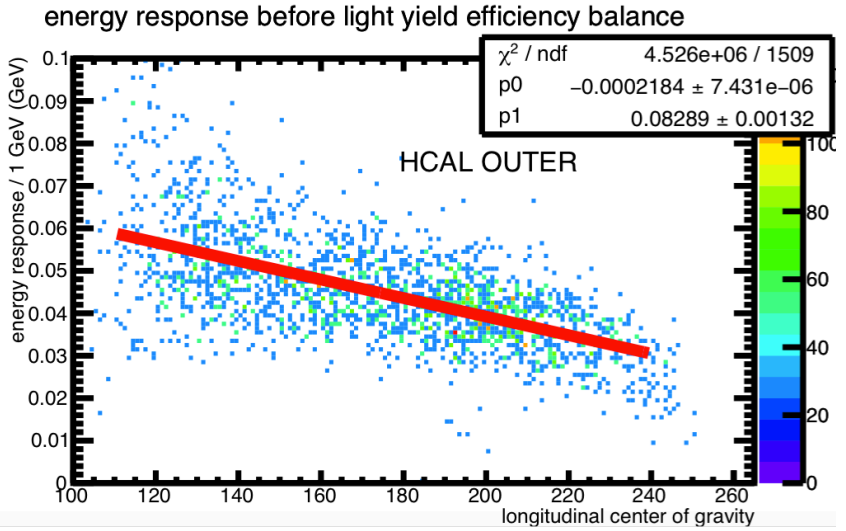
Before Light Eff Correction



SF for HCAL INNER



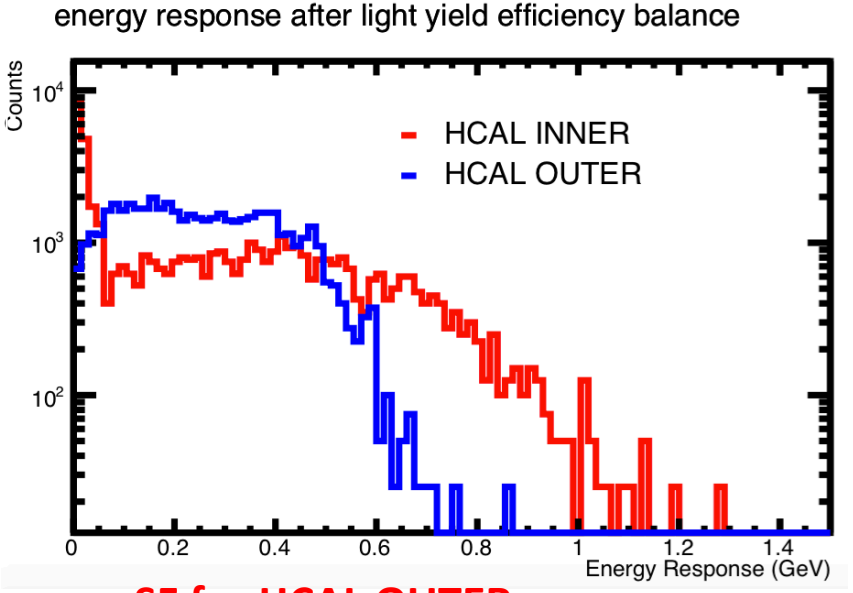
SF for HCAL OUTER



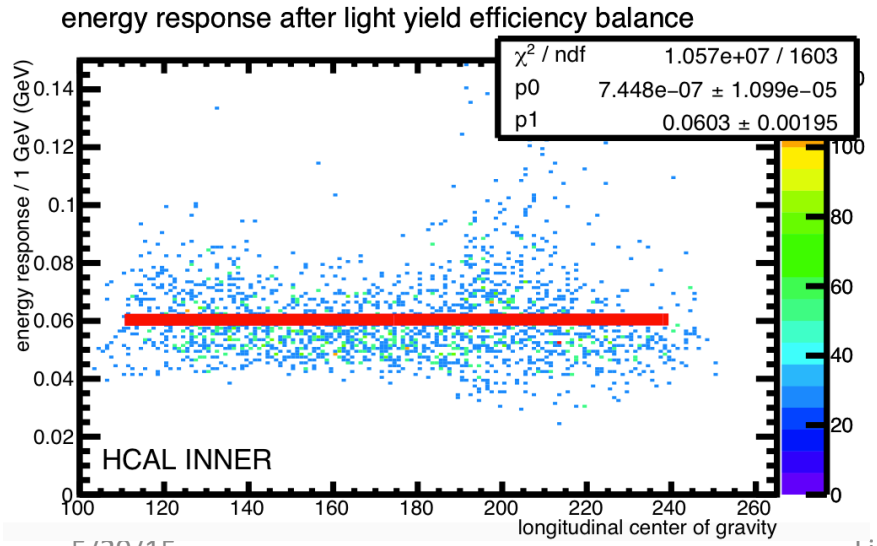
Energy response, sampling factors after light correction

- Outer HCAL have less energy response after light correction.
- Decrease trend removed for SF vs. longitudinal center of gravity (LCG) for HCAL inner and HCAL outer after light efficiency correction.

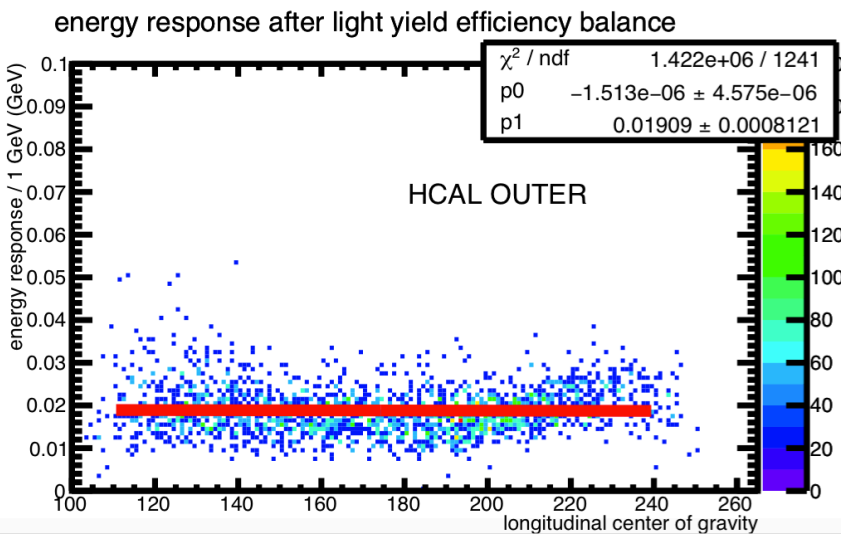
After Light Eff Correction



SF for HCAL INNER

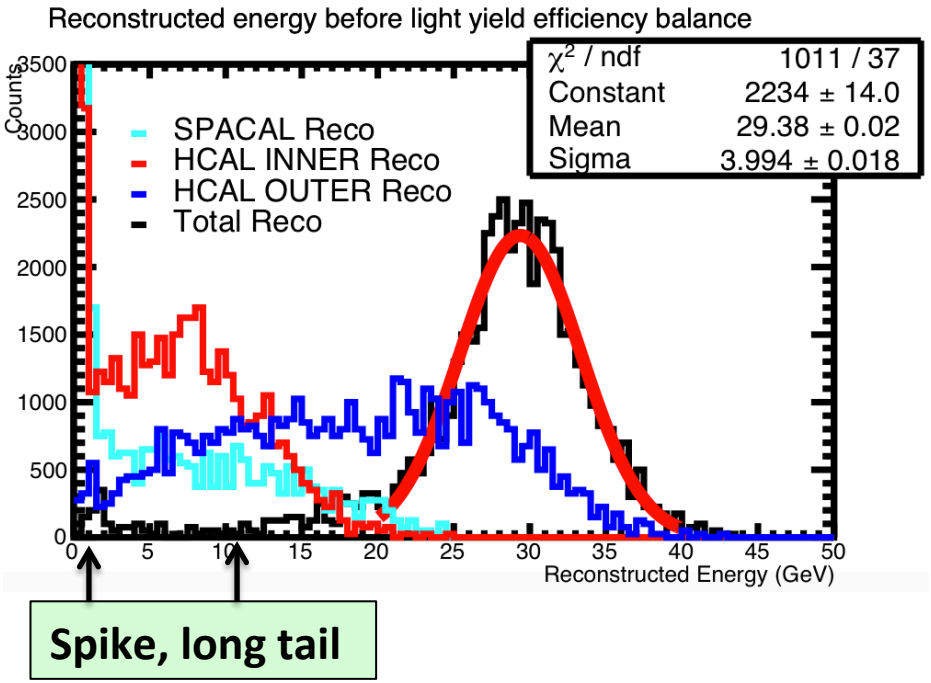


SF for HCAL OUTER

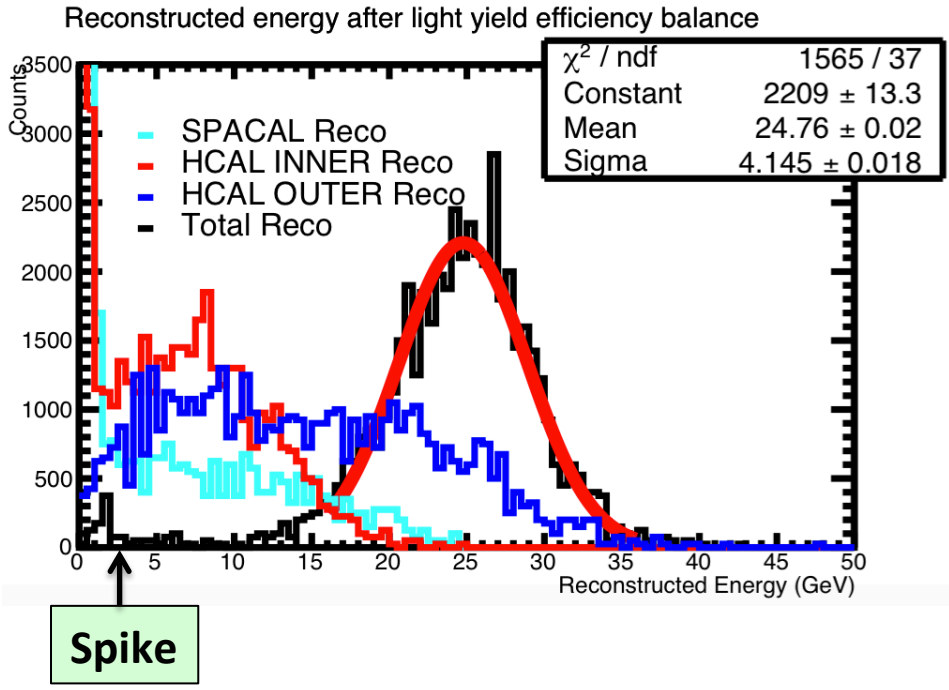


Reconstructed energy before/after light correction

Before Light Eff Correction

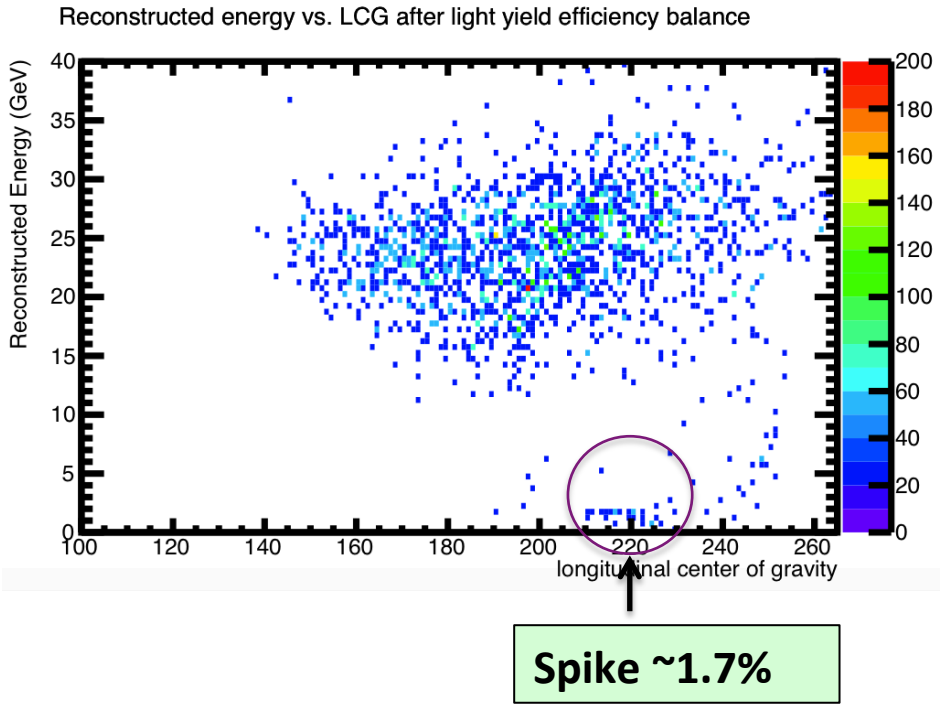


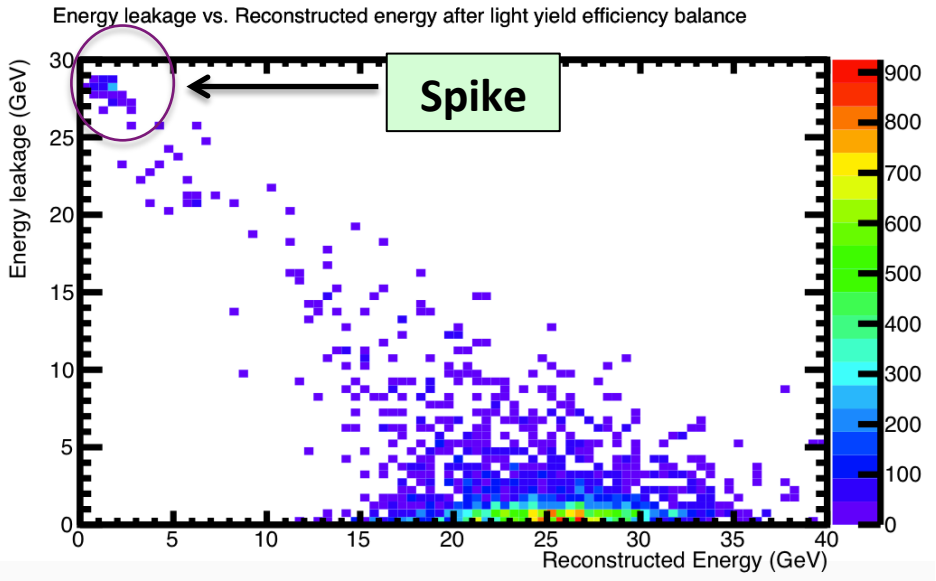
After Light Eff Correction

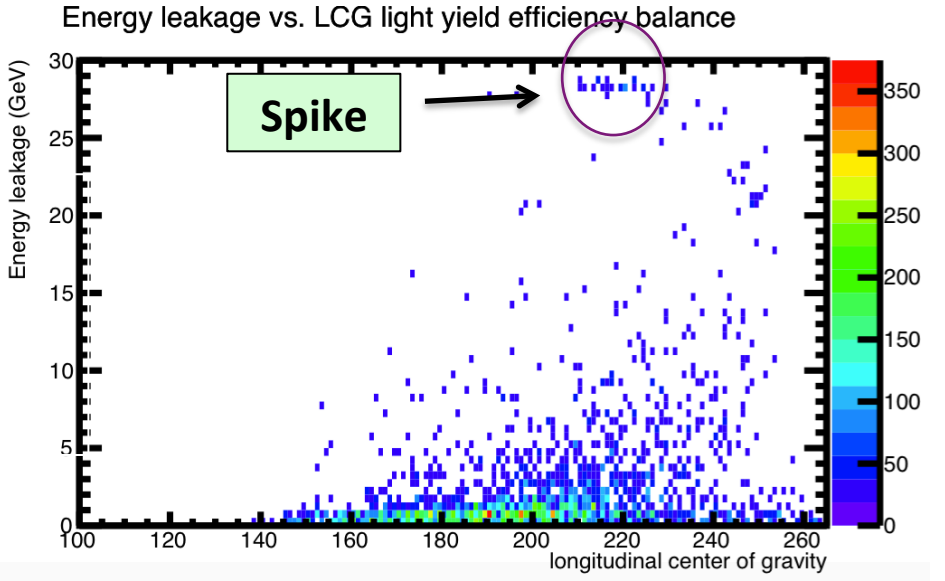


- Before light correction, reconstructed energy is over estimated due to that SF(mu)<SF(hadron).
- By applying light correction (smoothing energy response ie. SF vs LCG), reconstructed energy is then measured to be ~25 GeV due to light efficiency loss.
- The spike at 0 (channeling / punch through) is **~1.7% with E < 3 GeV**, after light correction.

Spike of the energy spectra







- Spike at 0 due to channeling / punch through is ~1.7% with E<3GeV.

Summary

- Light collection efficiency correction is studied with 30 GeV pion for SPACAL and HCAL sPHENIX reference design.
- Light correction with Eff(R_{out})=1.0, and Eff(R_{in})=0.15 for outer HCAL, and Eff(R_{out})=1.0, and Eff(R_{in})=0.8 for inner HCAL can used remove the SF dependence on LCG.
- Particle channeling/punch through is ~1.7% comparing ~2.7% for HCAL standalone.